METHOD FOR USING PORTABLE WIRELESS DEVICES TO MONITOR INDUSTRIAL CONTROLLERS

BACKGROUND OF THE INVENTION

This invention relates generally to process controls and more specifically to controlling a process by remotely controlling a programmable logic controller.

Companies can incur great expense when one or more processes are not working correctly or not working at all due to a simple failure or fault within the control system. Maintaining an on site engineer to monitor the process and make the appropriate correction is expensive and time consuming. Known methods of diagnosing and correcting control system faults remotely, typically require that an engineer handling the remote corrections have the proper PLC data available to him and is aware of the problem. There is a need for an off site engineer to have the capability to remotely monitor the operation of a PLC, obtain the proper PLC data that allows the engineer to become aware of a problem, diagnose control system failures and faults, and remotely adjust the operation of the PLC.

BRIEF SUMMARY OF THE INVENTION

In an exemplary embodiment, a programmable logic controller (PLC) is remotely controlled and monitored using a local server, the Internet, and a portable wireless device. A system for remotely monitoring and controlling input and output I/O devices connected to and controlled by a PLC includes a programmable logic controller (PLC), and a local server for exchanging communication with the PLC. The system further includes a wireless Internet Service Provider (ISP) server for exchanging communication with the local server using the Internet, and a wireless user communication device for exchanging communication with the ISP server. A user utilizes the Internet to remotely monitor the operation of a process being controlled by the PLC and inputs control commands to the PLC using the wireless user communication device.

More particularly, the wireless ISP provides a user with access to the Internet using the wireless user communication device. The PLC is connected to the local server, which is linked to the Internet and includes communication drivers that enable the PLC and local server to exchange communications. Using the wireless communication device, a user accesses the Internet to communicate with the local server, access PLC operational data, and input PLC commands and operational response data. Thus, a user can remotely diagnose and correct PLC problems, thereby avoiding costs incurred when the PLC adversely affects the process it controls.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is schematic of a system for remotely controlling and monitoring a controller using a portable wireless device in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 is a schematic of a system 10 for remotely controlling and monitoring an industrial controller using a portable wireless device. System 10 includes a programmable logic controller (PLC) 16, a local server 22 that exchanges communication with PLC 16, an Internet service provider (ISP) server 28 that utilizes the Internet to exchange communication with local server 22, and a wireless user communication device 34, which exchanges communication with ISP server 28. Wireless communication device 34 includes a user input device 40 for inputting commands and data to be transmitted to PLC 16 over the Internet and a display 46 to view information retrieved from the PLC over the Internet.

In operation, PLC 16 is used to control an industrial process (not shown) by outputting control signals or commands in response to various inputs. PLC 16 is a computer like device, having a processor 52, that reads, for example, voltage levels at terminals of an input module 58 and energizes terminals of an output module 64 based on a program stored in a programmable memory 70. PLC 16 is capable of using a plurality of input modules 58 and a plurality of output modules 64. A user programs PLC 16 with a program that is stored in memory 70 and executed by

processor 52. The program is a list of instructions that provide the desired results by monitoring the terminals of input module 58, and based on the state of the inputs, turn 'ON' or 'OFF' terminals of output module 64, thereby controlling one or more devices connected to PLC 16.

A programming device (not shown) uses a suitable programming language, such as ladder logic, to enter the program into memory 70. An exemplary programming device is a hand held programmer or a laptop computer. Generally, processor 52 continuously cycles through the program stored in memory 70, for example, checking the status of all terminals of input module 58 and determining program paths to follow based on input module 58 readings and updating the terminals of output module 64. When checking the status of input module 58, PLC 16 scans each individual input terminal to determine the state of each terminal, i.e. whether the terminal is 'ON' or 'OFF'. If there is voltage present at the terminal it is considered 'ON', while if no voltage is sensed the terminal is considered 'OFF'. This data is stored in memory 70. Processor 52 then executes the program stored in memory 70 and based on the input data the status of each terminal of output module 64 is updated.

In one embodiment, input module 58 is an input module that receives discrete inputs from devices such as limit switches, electric eyes, and push buttons. In another embodiment, input module 58 is an analog input module that uses an analog to digital converter to sense variables such as temperature, speed, pressure, and position and put the read data into a format that processor 52 can read. In yet another embodiment, input module 58 is an input module that receives inputs, for example AC or DC current, from devices such as mechanical switches . Additionally, input module 58 provides electrical isolation between the input terminals of input module 58 and processor 52 to protect PLC 16 from damage caused by electromagnetic interference (EMI) or radio frequency interference (RFI). Components such as optical isolators or optocouplers are used to provide electrical isolation on input module 58.

Output module 64 is capable of use with AC or DC devices such as solenoids, relays, contactors, pilot lamps, LED readouts and other electro-mechanical

devices. PLC 16 uses a power source to run processor 52 and drive the output terminals of output module 64, which are configured to minimize EMI and RFI. Therefore, output module 64 uses components such as optical isolators and optocouplers to provide electrical isolation between PLC 16 and a load (not shown) connected to output module 64. In an alternate embodiment, output module 64 is an analog output module that uses a digital to analog converter to produce analog outputs to devices such as motor operated valves and pneumatic position control devices.

Monitoring and controlling PLC 16 enables a person, such as a process or maintenance engineer, to regulate processes. In one embodiment, PLC 16 is linked to local server 22 using a network, such as a local area network (LAN). The communications mechanism between PLC 16 and local server 22 is any suitable PLC protocol, for example TCP/IP over an Ethernet. Furthermore, local server 22 is equipped with a suitable communications driver (not shown) that matches the communications mechanism of PLC 16. Therefore, appropriate persons with network access to local server 22, retrieve PLC operational data from PLC 16, analyze the data, and send PLC operational response data and commands to PLC 16. Thus, an engineer that does not have direct access to PLC 16 monitors and diagnoses the performance of PLC 16 and makes appropriate corrections using a network connection to local server 22.

In an alternate embodiment, an offsite engineer utilizes the Internet to access local server 22 thereby gaining access to PLC 16. PLC 16 is connected to local server 22 using a network, as described above. Additionally, local server 22 is adapted to access the Internet, thereby enabling an offsite engineer equipped with wireless communication device 34 to utilize ISP server 28 to access the Internet and communicate with local server 22. By accessing local server 22, the offsite engineer has access to PLC 16 to retrieve dynamic PLC operational data on demand from PLC 16. The engineer diagnoses the operational data, then sends PLC operational response data and appropriate control commands to PLC 16 to change or correct the performance of PLC 16. If the needed corrective actions are not feasible to make from a remote site, the offsite engineer contacts on-site personnel to take the necessary actions. Additionally, the off-site engineer, based on the diagnosis, has the advantage

of knowing what equipment or supplies are needed to correct the problem when he arrives at the site, thereby saving system down time.

When operational data is requested from PLC 16, local server 22 transmits the data to ISP server 28, which formats and processes the data into Wireless Markup Language (WML). WML is a markup language intended to specify content and a user interface for narrow band devices, including cellular phones, personal data assistants (PDA's), and pagers. WML is designed for use with wireless devices having small displays, limited user input facilities, narrow band network connection, and limited memory and computational resources.

After the operational data is formatted into WML, ISP server 28 utilizes a Wireless Application Protocol (WAP) to transmit the data to wireless communication device 34. WAP is an open, global specification that enables users of wireless devices, such as cellular phones, PDA's, and pagers to easily access and interact with information and services over the Internet. WAP compensates for constraints of handheld wireless devices, such as a small display and input devices, and limited computational resources, thereby enriching Internet access by wireless devices.

Once the operational data is converted to WML and sent to wireless communication device 34 using a WAP, the user views and analyzes the data. After the user analyzes the data, the user utilizes input device 44 to enter PLC commands and operational response data into wireless communication device 34. The input commands and response data are communicated to ISP server 28 and then sent to local server 22. Local server 22 converts the data to the appropriate PLC communications protocol. Wireless communication device 34 is a portable wireless device such as a cellular phone, PDA, pager, or any device supporting a WML browser.

In an exemplary embodiment relating to a power generation station (not shown), an offsite engineer utilizes system 10 to determine that there is a problem in a fault table (not shown) of PLC 16. The offsite engineer resets the faults and continues to monitor PLC 16 via wireless communication device 34. If the problem

persists the offsite engineer further diagnoses the problem to determine a cause, for example, a specific I/O module (not shown) of PLC 16 is bad. The offsite engineer then utilizes the information to determine a replacement part number for the I/O module and verifies whether a replacement I/O module is in stock on-site or whether the replacement part needs to be ordered. Using this information the off-site engineer is able to verify that the part will be on-site when he returns, thereby allowing him to restore the power generation station to operation more quickly.

Thus, by leveraging the cellular infrastructure that has been constructed by cellular telephone companies, an offsite engineer utilizes ISP server 28, the Internet, and local server 22 to monitor, diagnose, and control PLC 16 via wireless communication device 34 from any location with cellular Internet access in the world.

While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.